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EVALUATION OF A MODIFIED CARSWELL 300-C WARM AIR FURNACE

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CANADIAN COMBUSTION RESEARCH LABORATORY

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EVALUATION OF A MODIFIED CARSWELL 300-C WARM AIR FURNACE

by

R. W. Braaten* and T. D. Brown**

ABSTRACT

A Carswell 300-C warm-air furnace was modified by the removal of two heat exchanger tubes which had been identified previously as contributing the least amount of heat transfer. The removal of the two tubes reduced the unit efficiency by 1% when the system was fired at 1.0 US gph and by 1½-2% when the system was fired at 0.75 US gph. The absolute level of efficiency remained above 82% at all CO_2 concentrations above 9½%.

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INTRODUCTION

In a previous evaluation of the cyclic performance of a Carswell 300-C warm-air furnace (1), it was found that combustion gas temperatures varied considerably in the different heat exchanger tubes. It was found that blocking two of these tubes produced only a 1% drop in furnace efficiency. This indicated that it might be possible to completely remove these tubes without seriously degrading furnace performance. Accordingly, a furnace in which these tubes were omitted was prepared at the factory and supplied to the Canadian Combustion Research Laboratory (CCRL) for evaluation.

Figure 1 is an illustration of the heat exchanger array and Figure 2 is an end view of the heat-exchanger tubes, indicating the two removed from this furnace. No effort was made to balance the flow in individual tubes, or to re-arrange the tube layout to optimize the distribution of air flow around the tubes.

EVALUATION PROGRAM

The furnace was evaluated by determination of furnace efficiency using the stack-loss method, and by measuring the temperature rise across warm air duct sections mounted on the furnace. Instrumentation was according to normal CCRL practice, i.e. temperature measurement by thermocouples and flue gas composition analysis by infra-red paramagnetic instruments.

Test Procedure

A performance profile for the furnace was obtained by varying the setting of the air inlet band and noting the corresponding percentage of O_2, CO_2 and CO and flue gas temperature as well as the temperature rise across the furnace ducts. The burner from this furnace was then installed in an unmodified unit and the measurements repeated.

This test sequence was performed for two firing rates; 1.0 US gph as specified for the Model 300-C and 0.75 US gph, the minimum firing rate for which the 300 series furnace is rated.

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(1) " Performance of the Carswell 300-C Warm-Air Furnace During a 6000 Cycle Test" by T. D. Brown and R. W. Braaten ERP/ERL 77-69 (CF).

TEST RESULTS

Figures 3 and 4 show the performance profiles obtained from the test measurements. These indicate that when fired at 1.0 US gph the stack temperature of the modified furnace was about 16.5°C (30°F) above that from a standard unit. At 0.75 US gph the stack temperature of the modified furnace was about 28°C (50°F) above that from a standard unit. This results in an efficiency drop of about 1% at 1.0 US gph and 1½%-2% at 0.75 US gph.

In both cases the efficiency of the modified furnace was 82% to 84% at a zero to two smoke number range common in field servicing.

The temperature rise on the warm-air side of the furnace was 58°C (105 F) for the standard unit and 54.5°C (98°F) for the modified unit when fired at 1.0 US gph and 41.5°C (75°F) for the standard unit and 35°C (63 F) when fired at 0.75 US gph. Since the change in efficiency was very small, this indicates that the air flow in the modified furnace was substantially higher than that in the standard unit.

CONCLUSIONS

Modification of the test furnace by removal of two heat exchange tubes resulted in an efficiency drop of 1% to 2%. While efficiencies still remained at or above 82%, this drop was greater than expected based on the previous test. This indicates that changes in the air flow pattern on the warm-air side resulting from removal of the tubes did not provide increased heat extraction from the remaining tubes.

Removal of the tubes resulted in a lowering of the temperature rise across the warm air side of the furnace by 3.5°C to 6.5°C (7°F to 12°F). This is due mainly to an increase in the air flow rate.

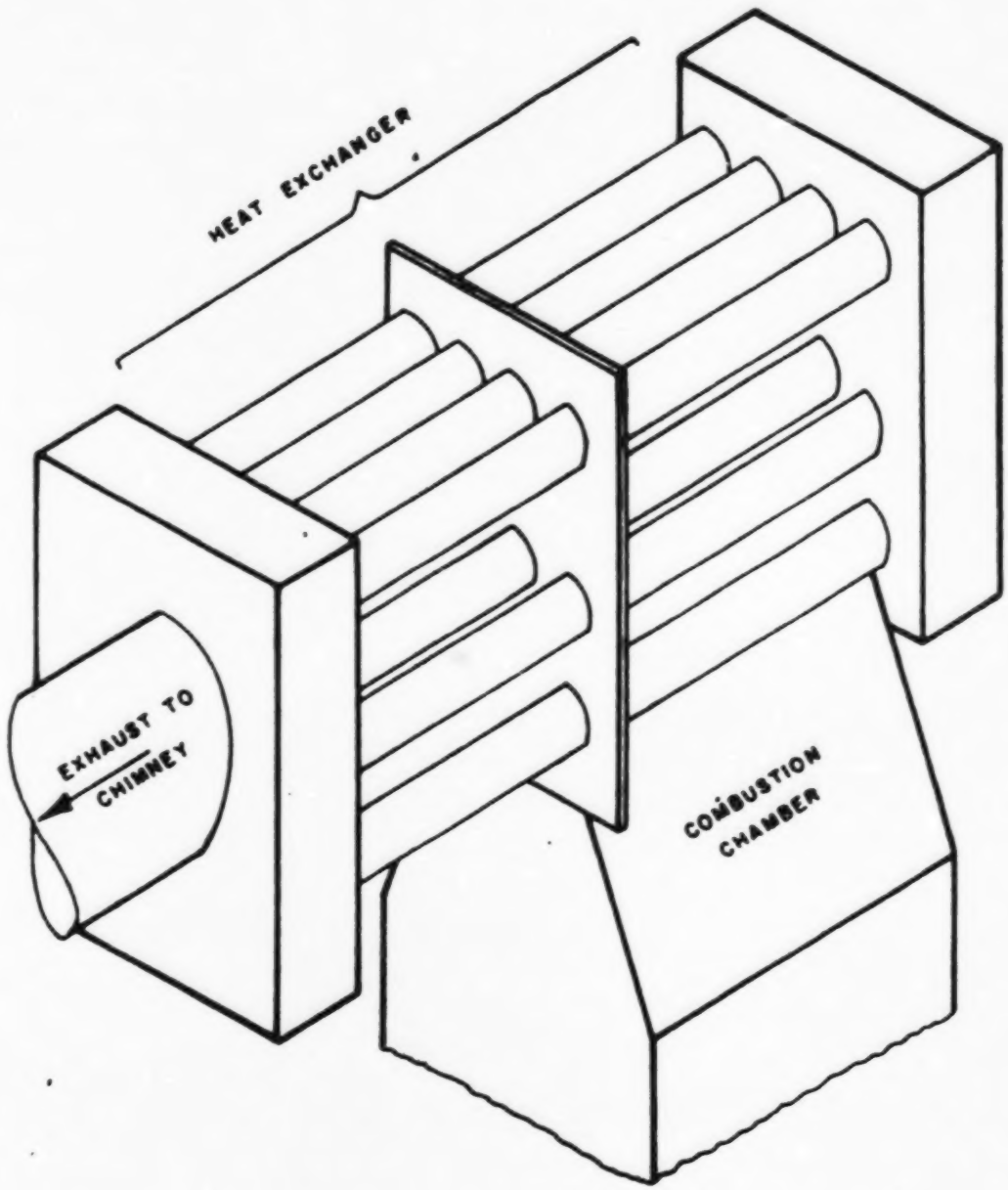
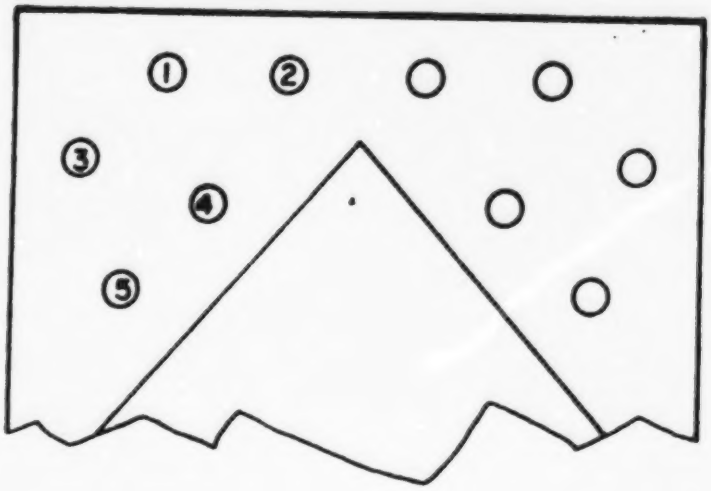
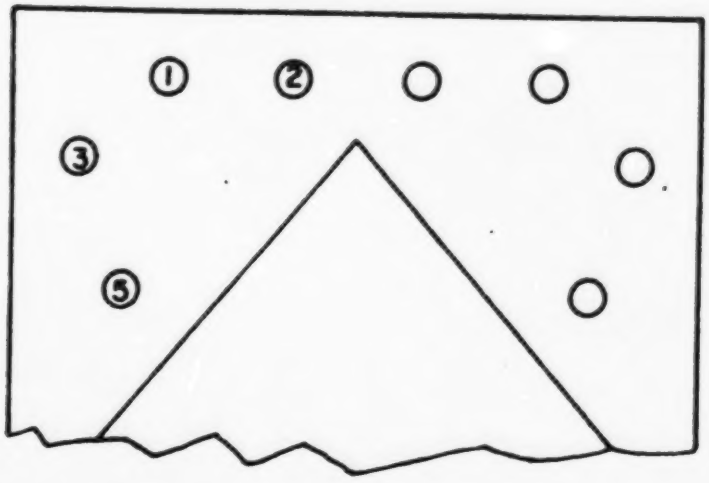


FIGURE 1. Heat-exchanger Array in the Carswell Furnace



A: ORIGINAL FURNACE



B: MODIFIED FURNACE

FIGURE 2. Section of the Heat Exchanger Tube Arrangement in Both the Original and Modified Furnace.